

REMARKS

Upon entry of this Amendment, claims 1-39 will be pending in this application.

Claims 1 and 7 have been amended solely for clarifying the claim language without the intention of narrowing the scope of those claims. Claims 9-39 have been withdrawn from consideration.

Claim Objections

Claim 7 is objected to because of informalities. Claim 7 has been amended and the phrase "said Si substrate" is replaced by the phrase "said Si crystal". Therefore, Applicants respectfully request withdrawal of the objection to claim 7.

Claim Rejections – 35 U.S.C. § 103

Claims 1-5, 7 and 8 have been rejected under 35 U.S.C. § 103 (a) as being unpatentable over Jacobs *et al.* (US Pat. No. 4,027,320) in view of Campbell, The Science and Engineering of Microelectronic Fabrication, pages 29-31. Applicants respectfully traverse this rejection for at least the following reasons.

With regard to claim 1, the Office Action contends that Jacobs *et al.* teaches a semiconductor device characterized by a silicon substrate (1); a silicon oxide film (4) containing Krypton (col. 2, lines 58-61). The Office Action concedes that Jacobs *et al.* fails to teach a silicon substrate comprising (111) oriented crystal. The Office Action contends that Campbell teaches a silicon wafer formed from a boule and having a (111) orientation. Applicants respectfully disagree.

Jacobs *et al.* describes a silicon oxide film used in the production of a storage element, the silicon oxide film containing Kr or Xe. The object of Jacobs *et al.* reference is to provide a memory device operating on the principle of carrier trapping. Kr and Xe atoms are introduced for the purpose of forming crystal defects or traps at the level of  $10^{11}$  lattice defects per  $\text{cm}^2$  or more and the Kr and Xe atoms are introduced by ion implantation into the silicon oxide film after the silicone oxide film is formed.

With regard to Campbell, this reference merely shows various orientations of a Silicon crystal. Campbell does not disclose, teach or suggest an insulation film can be formed on a (111) surface of the Si crystal.

In contrast, the invention as recited in claim 1 successfully achieves improvements of electric performance and reliability of the device by: (i) introducing Kr into a silicon oxide

film during a plasma process used for forming the silicon oxide film, and (ii) causing relaxation of stress by the presence of Kr atoms incorporated in the silicon oxide film and thus it becomes possible to form an insulation film on the (111) surface of the silicon crystal.

Therefore, the invention recited in claim 1 is directed to a completely different subject matter than the subject matter of Jacobs *et al.* which teaches formation of lattice defects or traps.

Moreover, there is no motivation to combine in either Jacobs *et al.* or Campbell because neither Jacobs *et al.* nor Campbell recognized the nature of the problem nor the solutions provided in the present invention.

As set forth in MPEP 2143.01, "In determining the propriety of the Patent Office case of obviousness in the first instance, it is necessary to ascertain whether or not the reference teachings would appear to be sufficient for one of ordinary skill in the relevant art having the reference before him to make the proposed substitution, combination or the modification." *In re Linter*, 458 F.2d 1013, 1016, 173 USPQ 560, 562 (CCPA 1972).

Applicants submit that prior to the present invention, when a thermal oxidation process is applied to a Si substrate having a surface orientation other than the (100) surface for forming a gate oxide film, there arises various problems in the gate oxide film such as increased surface state density at the oxide/Si substrate interface as compared with the case of forming the Si oxide film on the (100) oriented Si substrate (see for example page 2, lines 2-9 of the specification). Further, the oxide film formed on a surface other than the 100 surface suffers from the problem of poor breakdown voltage characteristics or poor leakage current characteristics (see, for example page 2, lines 10-13 of the specification). In contrast, the invention as recited in claim 1 provides an insulation film formed on a (111) surface of a Si crystal. By using an insulation film formed with a plasma containing a mixture of Kr and oxygen, on a (111) surface of a Si crystal, it becomes possible, for example, to form a high performance semiconductor device. Consequently, neither Jacobs *et al.* nor Campbell disclose, teach or suggest alone or in combination "an insulation film formed on said (111) surface of said Si crystal, wherein at least a part of said insulation film comprises a Si oxide film containing Kr." Neither reference recognizes the problems associated with forming oxide films on the (111) surface of a Si crystal, or any solution to the problem.

Claims 2-5, 7 and 8 are dependent from patentable claim 1. Therefore, Applicants respectfully submit that claims 2-5, 7 and 8 are patentable for at least the reason that they contain all the limitations of claim 1.

Therefore, Applicants respectfully submit that claims 1-5, 7 and 8 are patentable and respectfully request that the § 103 rejection of claims 1-5, 7 and 8 be withdrawn.

Claim 6 has been rejected under 35 U.S.C. § 103 (a) as being unpatentable over Jacobs *et al.* (US Pat. No. 4,027,320) in view of Campbell, The Science and Engineering of Microelectronic Fabrication, pages 29-31 as applied to claim 1, and further in view of Campbell, pages 394-396. Applicants respectfully traverse this rejection for at least the following reasons.

Claim 6 is dependent from patentable claim 1. Therefore, Applicants respectfully submit that claim 6 is patentable for at least the reason that claim 6 contains all the limitations of claim 1, and Applicants respectfully request that the § 103 rejection of claim 6 be withdrawn.

CONCLUSION

In view of the foregoing, the claims are now believed to be in form for allowance, and such action is hereby solicited. If any point remains in issue which the Examiner feels may be best resolved through a personal or telephone interview, he is kindly requested to contact the undersigned at the telephone number listed below.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached Appendix is captioned **"Version with markings to show changes made"**.

All objections and rejections having been addressed, it is respectfully submitted that the present application is in a condition for allowance and a Notice to that effect is earnestly solicited.

Respectfully submitted,

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Enclosure: Appendix

APPENDIX

version with markings to show changes made

IN THE CLAIMS

The claims have been amended as follows:

1. (Amended) A semiconductor device comprising [, characterized by]:  
a Si crystal having a (111) surface; and  
an insulation film formed on said (111) surface of said Si crystal,  
wherein at least a part of said insulation film [comprising] comprises a Si oxide film  
containing Kr.
7. (Amended) A Semiconductor device as claimed in claim 1,  
wherein said crystal surface forms a principal surface of said Si [substrate] crystal.

End of Appendix